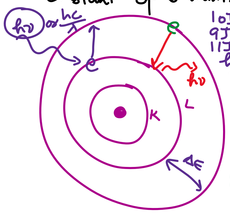
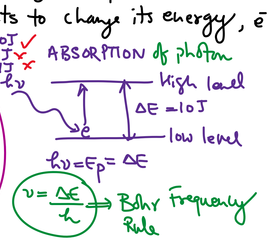
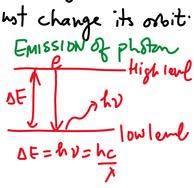
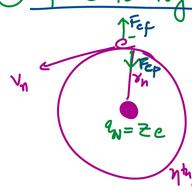
④ As long as e^- revolving in a particular orbit; its Energy remains constant. If e^- wants to change its energy, e^- must change its orbit.







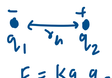
⑤ for e^- to stay in any orbit



F_{cp} Centripetal force = F_{cf} Centrifugal force

(Electrostatic force of attⁿ)

$$\left|\frac{Kq_eq_N}{r_n^2}\right| = \frac{m_ev_n^2}{r_n}$$



$F = \frac{Kq_1q_2}{r^2}$

$9\times10^9 \frac{Nm^2}{C^2} = K = \frac{1}{4\pi\varepsilon_0}$

$e = 1.6\times10^{-19} C$

$m_e = 9.1\times10^{-31} kg$

$$\frac{Ke\cdot Ze}{r_n^2} = \frac{m_ev_n^2}{r_n}$$

$$\frac{KZe^2}{r_n} = m_ev_n^2$$

Two imp Relations

① $m_ev_nr_n = \frac{nh}{2\pi}$ ② $\frac{KZe^2}{r_n} = m_ev_n^2$

Ⓘ r_n (radius of n^{th} orbit)

from ② $r_n = \frac{KZe^2}{m_ev_n^2} = \frac{KZe^2}{m_e\frac{n^2h^2}{4\pi^2m_e^2r_n^2}}$

from ① $v_n = \frac{nh}{2\pi m_er_n}$

$r_n = \frac{KZe^2 4\pi^2 m_e^2 r_n^2}{n^2h^2}$

$r_n = \frac{n^2h^2}{4\pi^2m_eKZe^2}$ ⇒ Remember this to get IIT

$1\,\text{Å} = 10^{-10}\,m$

$$r_n = \frac{(6.63\times10^{-34}\,J\cdot s)^2}{4\pi^2\times(9.1\times10^{-31}kg)\times(9\times10^9\frac{Nm^2}{C^2})\times(1.6\times10^{-19}C)^2}\frac{n^2}{Z}$$

$r_n = 0.529\times10^{-10}\frac{n^2}{Z}$ metres

$r_n = 0.529\frac{n^2}{Z}$ Å

Ⓐ Plastic

1) $r_3(He^+) = a_0\frac{(3)^2}{2} = \frac{9}{2}a_0 = 4.5a_0$

2) $\frac{r_2(He^+)}{r_3(Li^{+2})} = \frac{a_0\frac{(2)^2}{2}}{a_0\frac{(3)^2}{3}} = \frac{2a_0}{3a_0} = 2/3$

Ⓘ $r_1(H) = 0.529\times(1)^2\,Å = a_0$ (Bohr's first orbit)

ⅡⅠ $r_n = r_1(H)\frac{n^2}{Z}$

ⅢⅠ $r_n = a_0\frac{n^2}{Z}$

$a_0 = 0.529\,Å$

$a_0 = 52.9\,pm$

$1\,Å = 10^{-10}m$

$1nm = 10^{-9}m$

$1nm = 10Å$

$1Å = 0.1nm$

$1pm = 10^{-12}m$

Q. find radius of 2nd excited state of Be^{3+}?

n=1 → Ground state

n=2 → 1st excited state

n=5 ⇒ 4th excited state

Soln $r_3(Be^{3+}) = a_0\frac{(3)^2}{4}$ (n=3)

$= \frac{9}{4}a_0$

② V_n (Velocity of e^- in n^{th} orbit)

$m_ev_nr_n = \frac{nh}{2\pi}$

$$v_n = \frac{nh}{2\pi m_er_n} = \frac{nh}{2\pi m_e\frac{n^2h^2}{4\pi^2m_eKZe^2}} = \frac{2\pi KZe^2}{nh} = \frac{2\pi\times9\times10^9\times(1.6\times10^{-19})^2\times Z}{n\times(6.6\times10^{-34})}$$

$v_n = 2.18\times10^6\frac{Z}{n}$ m/s

$v_1(H) = 2.18\times10^6$ m/s

ⅡⅠ $v_n = v_1(H)\times\frac{Z}{n}$

$v_3(He^+) = v_1(H)\times\frac{2}{3}$

Q. $\frac{V_3(He^+)}{V_2(Be^{3+})} = \frac{v_1(H)\times 2/3}{v_1(H)\times 4/2} = \frac{1}{3}$

③ Time Period (T_n) ⇒ Time taken by e^- to complete one revolution around the nucleus in n^{th} orbit.

$v_n = \frac{2\pi r_n}{T_n}$

$$T_n = \frac{2\pi r_n}{v_n} = \frac{2\pi\times0.529\times10^{-10}\frac{n^2}{Z}}{2.18\times10^6\frac{Z}{n}} = 1.52\times10^{-16}\frac{n^3}{Z^2}\,sec$$

$T_n \propto \frac{n^3}{Z^2}$

④ Frequency of e^- in n^{th} orbit